Cornell Extension Bulletin 750

HARVESTING HANDLING and PACKING *Apples*

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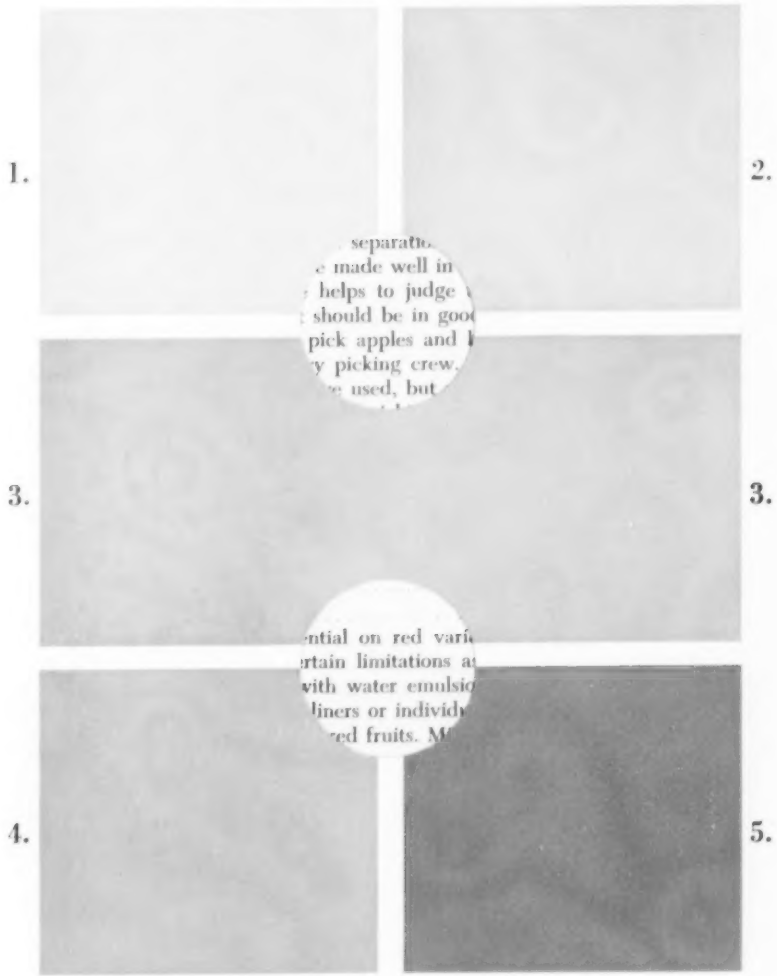
SUPPLEMENT

GROUND COLOR FOR McINTOSH APPLES



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In Brief

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Fruit may be bruised in every point of the harvesting and marketing operation: in picking, in the field container, in the hauling operation, in cold storage, in the warehouse, or in the retail market. Badly bruised fruit is unsightly and unattractive and actually ripens faster than unbruised fruit. Furthermore, cuts and bruises are points of entry for decay organisms. While the responsibility for rough handling is sometimes out of the hands of the grower, his is the initial responsibility to keep cuts and bruises to a reasonable minimum.

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Mechanized handling refers to the elimination of as much labor as possible by the use of mechanized equipment in packing houses. Such a system has both advantages and disadvantages. It requires less labor than hand handling; it is faster and thus should mean better fruit condition after storage; and there is less congestion in the packing house. The capital outlay, however, is considerable and some plants are not adapted to mechanization. 36

Few packing houses operate on a complete hand operation and use some mechanical equipment. For example, many growers use conveyors to move the fruit from the trailer to the stockpiling position, to move the packed boxes from the grader bins, or to move the apples to the end of the grader. Whether a conveyor system is cheaper than lift trucks depends in part on how much powered equipment is used. ..... 36 and 37

Skids or tow-trucks are often used to move boxes of apples, or "trains" or wagons loaded with filled boxes, around the packing house into storage. Many powered "elevators" are also available. Lift trucks, either of the clamp or fork type, are also used, as well as pallets. If one plans to use pallets, floor strength is a consideration as well as width, length, and height of the pallets. ..... 37 to 41

No one plan for mechanized handling of the fruit suits every situation. One plan is described in detail in the text—its use in the orchard, in the packing house, and in the storage. ..... 41 to 44

The Packing House ..... **44 to 47**

The efficiency with which a farm storage and packing house can operate depends to a considerable extent on how well it is planned. The layout of the packing house should be such that the fruit can be moved through the various steps involved in grading, packing, storage, and in merchandizing with a minimum of effort and expense. The equipment, too, should be arranged for efficient handling of the fruit. Floor dimensions have been determined in relation to the volume of fruit to be packed. Ceiling heights, also, must meet the requirements of the mechanized equipment used. There must be enough storage space for empty containers. Good lighting is essential—the right fixtures with the right bulbs and the proper adjustment to prevent glare are important considerations.

Harvesting, Handling, and Packing Apples

R. M. Smock and E. D. Markwardt[1]

Careful Handling

Freedom from Cuts and Bruises

The term *careful handling* sometimes has little real meaning. For example, the authors have watched occasional growers who paid lip service to "careful handling" throw apples 6 inches into boxes. On the other hand, one cannot afford to handle apples so carefully that there is never the slightest bruise on the fruit. The problem is to reduce bruises and cuts to a reasonable minimum. Apparently, too much bruised fruit is offered for sale; due in part to the fact that McIntosh, the principal variety sold on the fresh-fruit markets in New York State, is especially subject to bruising.

Badly bruised fruit is unsightly and unattractive to the consumer (figure 1). In fact, marketing studies show that consumers discriminate against badly bruised McIntosh in the store. Badly bruised fruit actually ripens faster than unbruised fruit; and rough handling stimulates the respiration and softening rate of a number of soft-fleshed varieties. Furthermore, cuts and bruises are points of entry for decay organisms. The major source of decay in apples is blue mold rot. This rot organism enters the fruit primarily through punctures in the skin. Fruit with no skin cuts is not likely to decay unless an organism, such as gray mold, spreads from apple to apple in the package.

How Apples Are Bruised

Rough handling can happen whenever apples are touched. Fruit can be bruised in the following ways at different steps in the handling and marketing operations:

Picking operation

- Improper use of ladders
- Method of picking
- Placement of apples in picking receptacle
- Type of picking receptacle

[1] The first edition of Cornell Extension Bulletin 750, with the same title, was written by F. W. Southwick and Melvin Hurd.

Figure 1. Roughly handled McIntosh
Major bruises must be prevented.

Field containers

- Type of field containers
- Method of placement of fruit in field container from picking receptacle
- Over filling of field containers

Hauling operations

- Care in piling field containers or packed boxes on trailers or trucks
- Trailer or truck construction and operation
- Rough roads
- Method of unloading trailers and trucks

In the packing house

- Method of movement of fruit to grader
- Method of dumping fruit onto grader
- Points of bruising in grader and sizer equipment
- Type of containers
- Protective pads, liners, or wraps in container
- Method of packing container
- Racking boxes
- Underfilling or overfilling boxes
- Putting lids on boxes

In the cold storage

- Method of moving apples into and out of storage
- Method of piling and unpiling boxes in storage
- Time of removal from storage (ripe apples show bruises worse)

In the warehouse

Length of time in warehouse without refrigeration

Methods of loading, unloading, and stacking

In the retail store

Length of time in unrefrigerated storage in back room of store

Method of making display

Method of filling consumer packages

Type of consumer package

Handling by consumers

Length of time on display in store

That fruit may be bruised at every point in the harvesting and marketing operation is shown in figure 2. The broken line, marked *special,* refers to McIntosh apples that were picked into pails and were graded by hand out of pails. The solid line, marked *regular,* refers to fruit picked into rigid-sided picking containers, dumped into field containers, and graded over a commercial grader. The "specially" handled fruit left the farm in better condition than did the "regularly" handled fruit; but by the time it was in the stores for three days, about 70 per cent of the fruit had three or more bruises per fruit. Nearly 100 per cent of

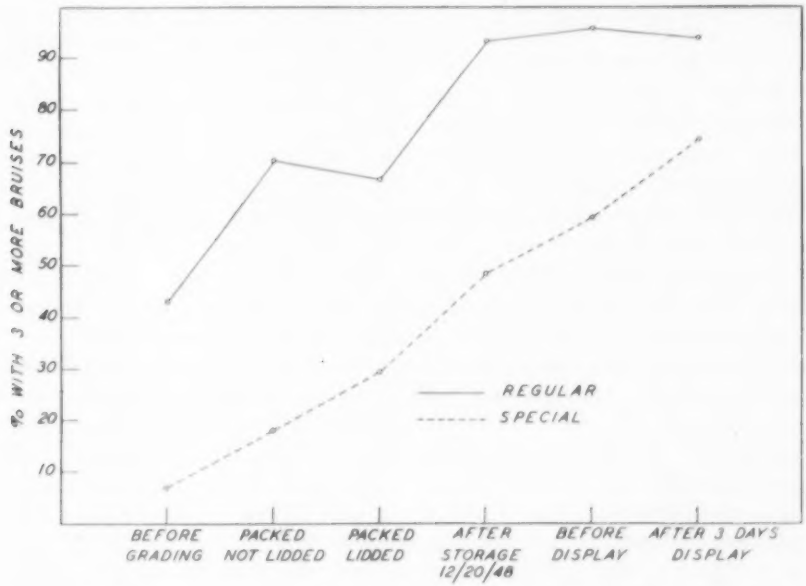

Figure 2. Increases in percentage of bruised McIntosh as a result of each step in the handling procedure

The broken line, designated "regular," represents apples picked in drop-bottom picking containers and put over a commercial grader. The solid line, designated "special," represents apples picked into pails and hand graded out of the same pails.

the regularly handled fruit showed three or more bruises per fruit upon removal from storage.

It is obvious from the foregoing outline that the responsibility for rough handling is sometimes out of the hands of the grower, but his is the initial responsibility. If the fruit leaves his farm in a bruised condition, he cannot blame the retailer. Sometimes growers overlook the amount of bruising that has been done before the fruit leaves the farm, because apples frequently do not show the effects of rough handling until they are ripe.

Harvesting

Time of Harvest

TIME of picking is a critical point in the commercial handling of apples. Apples picked too green are not so marketable as are riper fruit. They have less than the desired amount of red color, lack eating quality because they do not have their full amount of sugars, are susceptible to storage disorders, such as brown core, scald, and bitter pit, and do not have their full size. They are likely to shrivel in storage. On the other hand, apples picked too late are likely to be too ripe when removed from storage and are subject to storage disorders, such as Spy Spot, Jonathan spot, and mealy breakdown.

The best time to pick a variety varies somewhat according to how the apples are to be used. McIntosh to be used for baby food can be much riper than those to be held in storage for a long time. McIntosh to be held in controlled-atmosphere storage should be of prime maturity for long-time holdings. This means that the first-picked fruits may be too green and the last picked fruits too ripe for this type of storage. For long-time holdings, Rhode Island Greening keeps freerer from scald if it is picked after McIntosh.

For some varieties, one of several maturity indices is more important than another. Golden Delicious, for example, must have well-developed ground color. Golden Delicious apples that do not have their full golden color at harvest will not develop it in storage. In some years, red color development may be the critical index of the maturity of a variety such as McIntosh. Hormone sprays may be used to hold these apples on until the last possible moment to get color development, but such apples will not keep well in storage because of excessive softening.

Some red color sports should not be picked at the same time as the parent variety. Some persons pick them solely on the basis of red color and hence pick them too soon. There is, however, some evidence that certain red sports mature faster than the parent variety. For example, Red Rome and Red Spy do not seem to keep in storage so well as regular Rome and Spies picked at the same time.

Judging When to Pick

It is most difficult to tell a grower when to pick his apples. One might say that judging when to pick is more of an art than a science. Experience in judging when to start harvest is the most valuable help a grower can have. The grower must, however, base his judgement on certain indices that have some value. Some of these are the following:

Firmness

Apples soften as they mature on the tree (figure 3). Firmness can be measured fairly accurately with a Magness-Taylor type of pressure tester. The limitation of this test is based on variability in firmness rather than on the inaccuracy of the tester. Firmness for a given variety varies with season, climate, orchard culture, soil type, age of tree, and other conditions. A range of pressure tests in which some of our common varieties should be picked is given in table 1.

It is true that usually McIntosh apples may be picked at 15 pounds pressure test in New York; but, since in some years they should be picked at 14 pounds and in others at 16.5 pounds, it makes the test of questionable value.

Ground color

There is a gradual change from green to yellow in the ground (underlying) color of apples as they mature on the tree (figure 3). Some varieties, such as Rhode Island Greening, must be picked while still dark green because of their use for processing. Still others, such as Golden Delicious, need a fully developed yellow

Table 1. Approximate Guide When to Start Picking Apples

Variety	Firmness	Ground color on Cornell chart	Days from full bloom
	Pounds	*Colors*	*Number*
Duchess	14 to 16	2 to 3	95 to 105
Early McIntosh	14 to16	2 to 3	95 to 105
Wealthy	14 to 16	2 to 3	115 to 125
Rhode Island Greening	20 to 23	4 to 5	120 to 130
McIntosh	14 to 16	2 to 3	123 to 140
Cortland	16 to 18	1 to 2	135 to 145
Delicious	17 to 18	2	145 to 160
Baldwin	22 to 24	2 to 3	150 to 160
Northern Spy	19 to 22	1 to 2	150 to 165
Golden Delicious	18 to 19	1 to 2	145 to 165
Rome Beauty	19 to 21	2 to 3	150 to 165

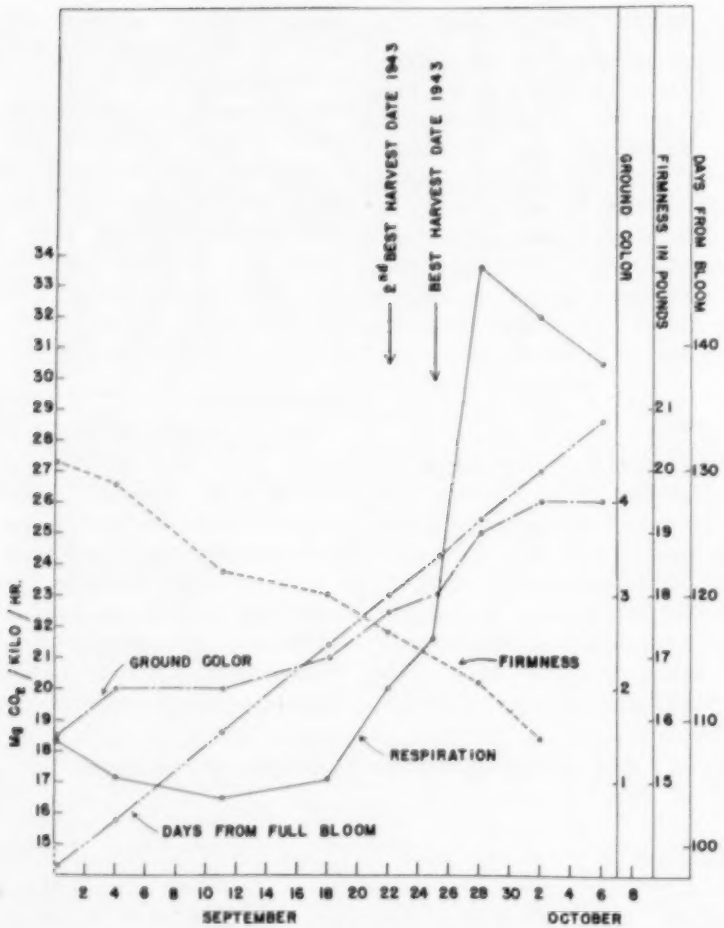

Figure 3. Actual information on maturity changes as McIntosh apples ripened on tree, 1943

ground color to have best eating quality and appearance. On some varieties, it is difficult to judge shades of green to yellow. The Cornell ground color chart for McIntosh was prepared to assist in judging the time to pick this variety. Colors 2 and 3 seem to be the ground colors at which this variety should be picked. Some growers prefer to pick at 2.5 and others at 3. The ground-color chart is available with this bulletin.

Ground-color estimation is the

most reliable of the indices as to when to pick varieties that are not completely red (such as the red sports). It has the limitation of varying some with season, section, and nutrition. For example, high-nitrogen-level McIntosh may, if not picked before it reaches a ground color of 3.0, be too soft for long-time holdings.

Ease of separation

No variety should be harvested when picking the fruit means pulling out the stem or pulling off the fruit spurs. Obviously, picking has been delayed too long if the fruit drops into the hand upon barely touching it. Observation of the amount of dropped apples under the tree is another way to use this index. The value of this index has been lessened by the increasing use of hormone sprays to prevent dropping. After the use of such hormones, the fruit may be tightly attached to the tree even though proper picking time has been reached or passed.

Days from full bloom

Some investigators recommend counting the number of days from full bloom in any given year and harvesting after the suggested interval for maturation (table 1 and figure 2). It should be remembered that the information given in table 1 refers only to *average* number of days from full bloom and only to apples grown at Ithaca, New York. With McIntosh at Ithaca, the range from full bloom to best harvest date has been from 120 to 157 days. The very long season was in a year in which the bloom was almost a month earlier than normal. When the very early blooming-season information is discarded, the average comes closer to 130 days.

Calendar date

Maturity studies at Cornell show that calendar date is a more accurate index of when to pick McIntosh than is days from full bloom. In a seven-year study, the best pickings of this variety were made in a range of only five days in calendar date. One should not rely too strongly on calendar date, however. A grower may figure that he usually starts picking McIntosh about September 10. If the month preceding happens to have been cool and cloudy, he may find he should delay picking a week on the basis of other maturity indices. With the later varieties, calendar date is an even poorer guide because there might be a great deal of cool weather in late September and in October which would delay maturation.

Other suggested tests

Some investigators have recommended the use of the starch test to judge when to pick. Slices of apple are stained with iodine solution. The picking date is determined by matching the degree of blackening of the stain with a

standard chart. This test has been too erratic to be useful in New York.

The grower naturally wants the maximum amount of red color, but he cannot pick solely on the basis of the amount of red color. The red sports may have full red color long before they should be picked. If the grower waits too long for red color in a season not conducive to good color development, the fruit may be over-ripe.

Blackening of the seeds is a rough guide, but is too erratic to be very accurate.

Preparation for Harvest

Preparation for harvest should be made well in advance of expected harvest date. A rough guide to help estimate the probable starting time to harvest is given as "days from full bloom" in table 1. The grower should estimate as closely as possible what his crop size will be and have all equipment ready for operation. An estimate of crop size helps to judge the number of pickers and packers required. Growers should have ladders, field crates, picking receptacles, and trailers in readiness

Figure 4. The correct way to pick an apple

The index finger is placed at the point where the fruit stem and spur are joined. The apple is raised slightly and the spur is not broken off.

as well as roadways smoothed and orchard trailers or trucks with good springs and pneumatic tires available. The grader and sizer in the packing house should be in good repair.

Picking the fruit

The picker is interested in speed of harvest as well as in careful handling. Careful instruction to each picking crew is always a necessity. New pickers need to be shown, not just told, how to pick. Where pickers cannot be checked closely by the orchard-picking foreman, it often pays to have each picker place numbered tickets in the boxes he fills. Any badly bruised fruit that shows up in the packing house can then be traced to the picker who is at fault.

The picking foreman or supervisor is usually the key to a good picking operation. He not only carefully checks for bruises but checks the pickers' tickets for each box picked. He shows pickers what trees to pick and where to place the filled boxes.

Probably the best way to pick apples is to raise the apple to one side with the finger and twist the wrist (figure 4). If the apples are still rather tightly attached to the spurs, the thumb or forefinger should be placed next to the stem. An effort must be made to keep the stems from pulling out and to keep the spurs from pulling off. Both hands should be free for picking, but to pick two apples in one hand badly bruises the softer varieties.

Pickers should pick as much fruit as possible from the ground before they even set a ladder. They should then pick as they move up the ladder. The picking foreman should instruct new pickers on how best to set a ladder safely without knocking apples off the branches.

Each picker should be carefully instructed on how to place the apples in the picking container. They must be *placed* and not dropped!

Spot picking is required with some varieties. In all varieties there is a spread in the time of ripening even on the same tree, but it is more pronounced in some varieties than in others. Irregular ripening and the necessity of picking the prime fruit at several separate pickings is more prevalent in the early varieties, such as Duchess, Early McIntosh, and Milton. Some growers even spend extra money to spot pick such varieties as McIntosh and Delicious so that the greener fruits can color properly and yet prevent the drop of the fruit ready for picking.

Picking containers

A wide variety of picking containers are used for apples. Probably most widely used is the rigid-sided, drop-bottom picking bag. In a canvas bag without rigid sides, the apples tend to move around in the bag as the picker moves up and down the ladder. Also, the sides of the bag may bang against the lad-

Figure 5. Packing apples in the orchard
The fruit is packed directly from the picking container into the market box.

der, which causes bruising. Some growers pick in pails, usually when the fruit is hauled to the packing table for hand sorting and sizing. With this method, there is a loss in efficiency, but mechanical damage is kept to a minimum (figure 5). The picking containers must not be over-filled.

Dumping of the picking container is an important step and must be carefully supervised. The ideal way to empty the picking container is to transfer the fruit by hand to the field container. This is an expensive operation because of the time consumed. If the picking container is "dumped," it must be done with great care. The grower must instruct the pickers to place the full picking container on the bottom of the field container before he loosens the fasteners. Then the picking receptacle must be lifted slowly and gently so that the apples roll slowly into the field container.

Field containers

A wide variety of containers are used to haul the fruit from the orchard to the packing house. The standard Northeastern box is commonly used in New York. Some growers use the new boxes that take the apples to market after grading, packing, and storage. Others use secondhand Northeastern boxes.

Some growers prefer heavy-

weight field crates that are kept on the farm. These heavy field crates last for many years with careful handling. Others growers use slatted crates similar to potato crates. These slatted crates need liners to prevent the edges of the slats from bruising and cutting the fruit. Occasionally a grower can buy secondhand boxes, such as beer cases, for his field containers.

Ladders

Three-legged stepladders with an adjustable back leg can be used on low trees. Those that flare out at the base and taper to a point or to a width of about 1 foot offer some safeguard against tipping. These ladders may have the bottom of the beams pointed and shod with strap iron to prevent slippage.

New pickers always need careful instruction on setting ladders. Ladders must be set as upright as possible to put weight on the base rather than on the tree limbs. The top of the ladder should rest in the crotch of two fair sized limbs or against a large limb.

Ladders made of aluminum or magnesium are lighter in weight and more permanent than wooden ladders but are much more expensive.

Care of Harvested Fruit

Apples should be removed from the orchard as quickly as possible after picking. Picked fruit should be in storage within 24 hours, and no later than 48 hours, after harvest. With a variety such as McIntosh, each day's delay in the orchard may mean the loss of 10-days storage life at 32° F. Furthermore, any field mice, which enter containers that stand in the orchard for any length of time, may be taken into storage if the fruit is stored field run. It is true that fruit picked in the late afternoon may lose considerable field heat if left in the orchard over night, but this delay may encourage the presence of field mice.

Harvested fruit should always be placed on the shady side of the tree, for the rays of the sun can burn exposed fruit considerably as well as heat the fruit excessively.

Prestorage Treatments

Sun Coloring

Red color development is essential on the red varieties. In some seasons and in some sections, color development may be poor, particularly on high-nitrogen-level trees or on poorly pruned trees. Such fruits may drop before they get enough red color. Stop-drop hormone sprays have, however, partially solved this problem.

Another approach to the problem is "sun coloring." The apples are picked and are then exposed to the ultra-violet rays of the sun for 7 to 10 days until they develop red color. They are usually turned once so that more than one side can develop color. One method of sun coloring is to place the apples in a

single layer, with the green side of the apple exposed, under the spread of the trees where they will not get the direct rays of the sun. Direct sun will scald the fruit. Another way to sun color fruit is to lay the apples out on straw in a sun-coloring "frame." Posts in the frame support from two to three layers of cheesecloth to prevent sunburn. The cheesecloth filters out most of the infra-red or heat rays and allows much of the ultra-violet rays to penetrate to the fruit. The posts are high enough so that trucks can drive under the cheesecloth to unload and load the fruit.

There are several limitations to sun coloring. The fruit ripens rapidly while being colored. Hence, it should be sold as quickly as possible. The vapors from these ripe apples tend to ripen prime apples in the storage. Sun coloring is also expensive because it involves three extra handling operations. Mouse damage is sometimes a problem. If the apples are not on straw and there is rain during the coloring period, the apples may get dirty.

Waxing and Wrapping

Apples are sometimes waxed with water emulsions of various waxes, such as paraffin and carnauba, principally to reduce moisture loss from varieties such as Golden Delicious and to improve the appearance of the fruit. Waxing is an added expense, and the fruit must bring enough premium in price to offset costs. It is also an extra handling operation that can result in bruising.

Individual fruit wraps or box liners of materials such as polyethylene, pliofilm, cellophane, saran, and aluminum foil have been used to cut down water loss from stored fruits. Box liners are cheaper to use than are fruit wraps. Any fruit wrap or box liner completely impervious to carbon dioxide or oxygen would cause the fruit to become off-flavored. If sealed box liners are used, the films must be perforated upon leaving storage to prevent the apples from losing flavor before they reach the consumer. The storage scald disease is worse on scald-susceptible varieties when such wraps or liners are used.

Mineral-oil paper is often used to control scald. This paper, which is impregnated with 18 to 20 per cent by weight of pure, odorless, tasteless, mineral oil, is put with the fruit before storage. It may be used as fruit wraps or it may be added as shredded oiled paper at the rate of ½ pound per box of apples. Little fruit is wrapped in New York State, but some growers use shredded oiled paper. Seldom is enough shredded paper used to really reduce the scald disease. Furthermore, oiled paper is not always a guarantee against scald.

Wiping and Washing

Sprays for insect and disease control may leave excessive residues at harvest time. The Pure

Food and Drug Administration establishes tolerances for the amounts of spray materials that may remain on fruit at harvest time. These tolerances change from time to time, and the grower must keep informed as to the possible necessity of having to remove excessive spray residues. In 1954, the unofficial tolerances were 7 ppm (parts per million) for lead, 7 ppm of DDT, 2 ppm of Parathion, and 0 ppm of mercury. The usual procedure is to so arrange the spray program that the tolerances will not be exceeded at harvest time. For example, mercury is used only during the beginning of the growing season to prevent possible residues at harvest time. Certain spray materials, such as sulfur, carbamates, and nicotine, are not classed as toxic and no tolerances exist for them.

Spray residues that do not greatly exceed the tolerances can be brought below the tolerances by wiping the fruit. Revolving brushes, rotating cloth wipers, or both may be used in the equipment to clean the fruit partially. Wiping machines or brushers cannot be expected to remove more than from 15 to 25 percent of the total residues.

When spray residues greatly exceed the tolerances, the fruit must be washed. For residues such as lead arsenate, 1 percent hydrochloric acid followed by a clean water rinse is used in fruit-washing machines. No satisfactory removal agent is known for DDT. The materials that remove DDT remove too much of the natural wax of the fruit.

At present (1954), almost no fruit is washed in New York. Spray residues are kept below the tolerances by judicious use of the spray schedule. Washing and wiping, when practiced, are primarily to clean dirty fruit.

Grades for Apples

All apples sold in closed packages in New York must be marked with variety name, grower's name, location of orchard, grade of apples, size or count of fruit, and size of the package. Size may be expressed in terms of cubic contents of the package (such as 1⅛ bushels) or of numerical count of fruit in the package. Of course, consumer packages are marked as to weight of fruit in each package.

The details of the grading law are too extensive to be included in this bulletin. Furthermore, grade requirements change from time to time. Current grade requirements for apples can be had by writing to the New York State Department of Agriculture and Markets at Albany, New York.

Time of Grading and Packing

There is no best time to grade and pack for all growers. Probably most New York growers grade and pack in the fall before storage. Often there is considerable advan-

tage in packing at least a certain percentage of the fruit after storage. This gives buyers a "fresh pack" free from scald, decay, and other serious defects. Packing after storage usually means handling softer fruit that cannot tolerate rough handling in the grading and packing operations. Storing field run means that storage costs will be higher for the actual number of boxes sold. It is sometimes difficult to dispose of off-grade apples late in the storage season. Storage of field-run apples usually means more prompt cooling and smaller packing crews.

Sorting and Sizing

Hand Sorting and Sizing

FRUIT may be hand packed in the orchard or in the packing house. It consists of sorting and sizing fruit from tables or field containers into suitable market or storage containers. The equipment used in the orchard should be light in weight and easily portable so it may be readily moved through the orchard with the pickers. Tables constructed so that the apples may be transferred directly from packing or field containers into the market container are superior to canvas-bottom or slat-bottom tables onto which the fruit is placed for sorting and sizing (figure 5). Excessive bruising is frequent on slat-bottom tables. Any table onto which apples are placed should be well padded.

Fewer injuries to the fruit is the main advantage for hand sorting and sizing. With careful supervision, this may be true; however, the type of equipment used and the way it is used largely determine the best method to use.

Mechanical Sorting and Sizing Equipment

Mechanical equipment has quite largely replaced hand tables because of its greater efficiency and speed in handling a large crop.

A grader is essentially an assembly line where each person has his own particular job. The fruit is conveyed from the receiving table or belt to the sorters and through the sizing devices to the packers. Each person on this assembly line has one particular job in which he specializes and for this reason the pack is probably more uniform than when each individual does his own sorting, sizing, and packing.

Dumping equipment

The first unit on a grader is the space to place the tree-run apples. This is either an endless receiving belt or a sloping feed table over which the apples roll to the next unit. Receiving belts are much better than feed tables because the fruit does not tend to pile up when it is conveyed away as it is "dumped."

Fruit may be badly bruised when it is put onto the grader (figure 6). A little care in turning

over the box minimizes the amount of bruising. Merely using one's hand to keep the apples from spilling out all at once helps some. A pad, such as that shown in figure 7, is considerably better. The operator holds the pad over the top of the box while he tips the box, then he gradually lifts it off to allow the apples to come out gently onto the receiving belt. Counter-balancing this pad makes it easier to use. Such a device is simple and inexpensive.

Another inexpensive device is shown in figure 8. The operator places a canvas bag, with one end tacked to the grader, over the top of the box of fruit while he tips the box over. Then he releases the

Figure 6. A sure way to bruise apples
Bruising is excessive when fruit is dumped in this manner.

Figure 7. Hand dumping apples onto grader
Counterbalanced pad on top reduces bruising in the dumping operation.

Figure 8. A canvas bag to prevent bruising

The grower puts a canvas bag over the top of the field crate while he tips the crate upside down on the feed table. He gently lifts the crate off, thus causing little damage to the fruit as it rolls onto the table.

bag and lifts the box gently to allow the apples to flow out.

Mechanical dumping also helps a person to do a better job with less exertion. Since the job is so much easier, it is not so difficult to get workers. Tests indicate, however, that bruising is no less with these dumping devices than with careful hand dumping with a padded board. In fact, reasonable care must be exercised in either method, for even a conscientious person tires and becomes careless lifting 50-pound crates all day.

One mechanism consists of a pivoted crate holder in which a strong coil spring assists in elevating and tipping the crate. As the crate is raised it comes in contact with a padded hinged cover which is restrained by spring tension. This regulates the flow of fruit out of the crate (figure 9).

Also available are almost completely automatic box dumpers such as the one illustrated in figure 10. They do an acceptable job from the standpoint of not bruising the fruit: they require less labor, and can be adjusted for the rate of dumping. They are, however, relatively expensive.

In hand dumping, the type of surface on which the fruit is dumped also affects the amount of bruising. Receiving belts are much better than bins. The portion of the belt where the fruit is actually dumped should have no solid surface underneath. The belt should be merely under tension so it "gives" when the fruit is dumped onto it. Tests show that fruit dropped 1 inch on a hard surface bruises, whereas fruit dropped up to 6 inches on a belt under tension does not bruise.

On many graders, apples are conveyed from the feed table or belt to a 2-inch mesh metal or rubber-belt sizing unit. This sizer is referred to as a *cull eliminator* because the culls are removed. After the apples have passed over the cull eliminator, a brusher or wiper helps to remove spray residue and to improve appearance or "polish" of the fruit.

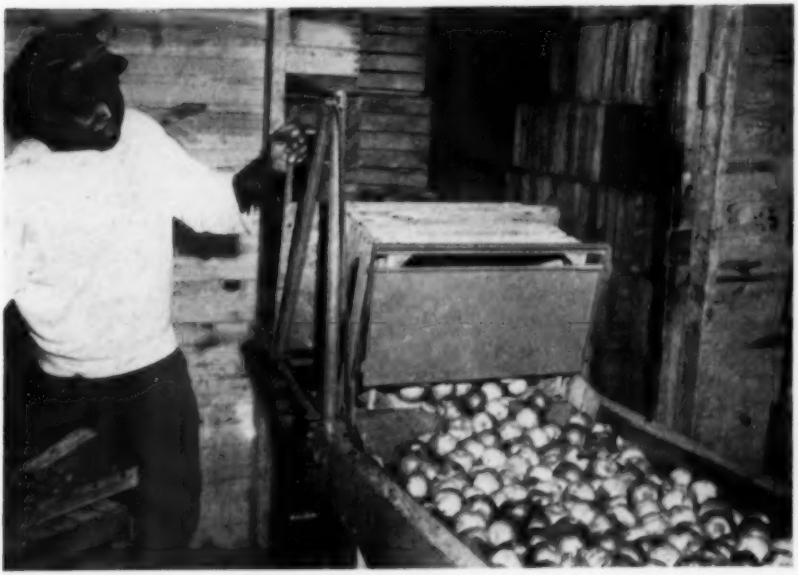

Figure 9. A mechanical dumping aid

This aid greatly reduces the effort in dumping fruit onto a grader, and the padded, hinged top prevents the fruit from spilling out all at once.

Figure 10. Automatic box dumper feeding apples onto roller sorter

Sorting equipment

Apples are inspected or graded on two types of roller conveyors or on endless belts. One type of roller conveyor has wooden cylinder-like rollers parallel to the flow of the fruit. Sash cord, wrapped spirally around this roller several inches apart, turns the apples over and moves them forward.

On the most common type of sorter, the rollers are at right angles to the flow of fruit and turn the fruit, exposing all sides as they are being conveyed. Leaves are eliminated and, since the fruit is constantly being turned, apples with blemishes can be easily detected and removed. Wooden cylinder-like rollers are most commonly used, but some manufacturers cover the rollers with sponge rubber (figure 12) which practically eliminates any bruising when the fruit strikes the roller. Fruit when being transferred to the roller sorter drops a short distance and therefore strikes the rollers with enough force to be bruised. Also, in sorting, the operator picks up the fruit and in moving it to another position on the sorter, may place it down with enough force to cause some bruising. The rubber-covered rollers help to prevent bruising in this operation.

Methods of sizing and types of equipment

Correct sizing is important to meet New York State apple-grade requirements. According to New York State rules (Circular 650[2]) "more than 5 per cent of the apples in any container may not meet the size requirements, provided that when the maximum and minimum sizes are both stated an additional 10 per cent tolerance is provided for apples which are larger than the maximum size stated." Size refers to the transverse diameter measured at right angles to the core.

Basically there are two methods of sizing fruit: (1) by weight and (2) by diameter. Actually, the fruit is separated and graded into groups of the same range in diameter whether the weight or diameter is used as a measure. That is, even with weight sizers the weight of an apple gives an indirect indication of its diameter. A certain inaccuracy results because of the variations in shape and density of the fruit. Many apples vary in shape so that they do not have a constant transverse diameter. The fruit is usually sized according to the largest transverse diameter unless it is misshapen enough to put it into a lower grade or into a cull bin. Variations in shape and density cause variations in the weight of apples of the same diameter.

Weight-type sizer

Theoretically, the weight type of sizer is more accurate than the diameter type, but there are practical

[2] From the New York State Department of Agriculture and Markets, Albany, New York.

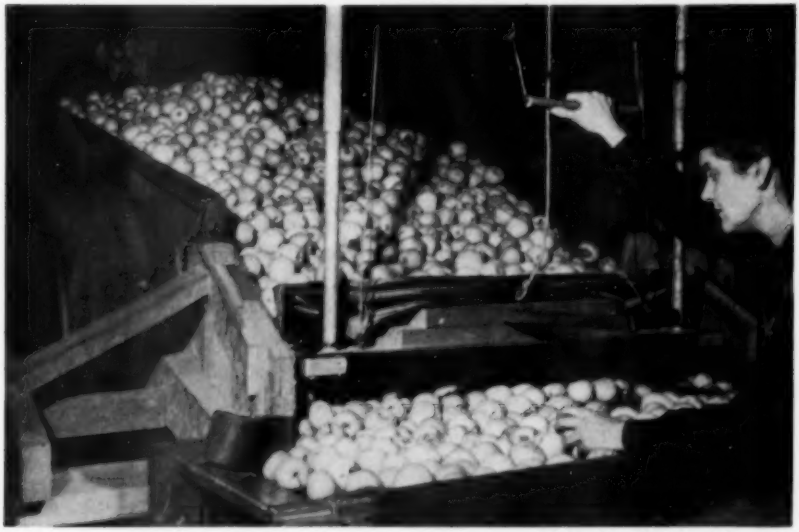

Photo by Claude Bailey, Jr.

Figure 11. A small trailer load of apples being dumped onto grader

Apples from picking receptacles are dumped into a number of such trailers in the orchard. The trailer is elevated at far end by an electric hoist to deliver the apples slowly to the grading table.

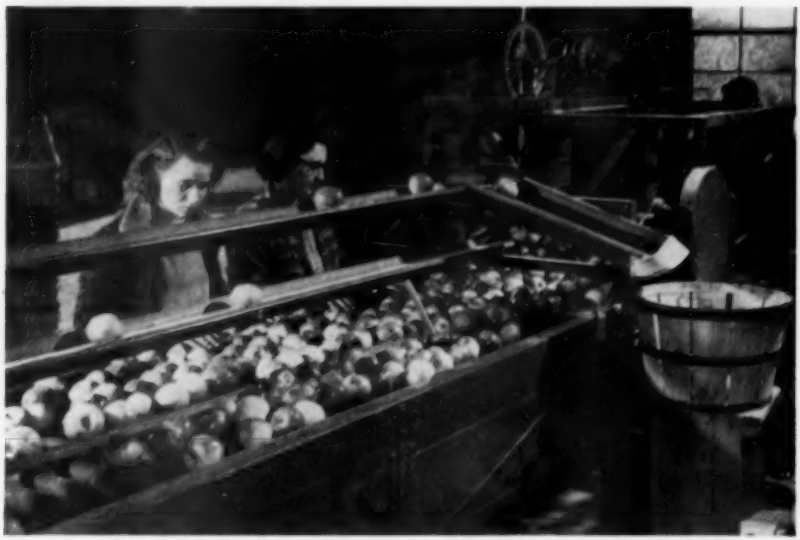

Figure 12. Sorting apples on a sponge-rubber-covered roller

The sponge-rubber helps to reduce the amount of bruising.

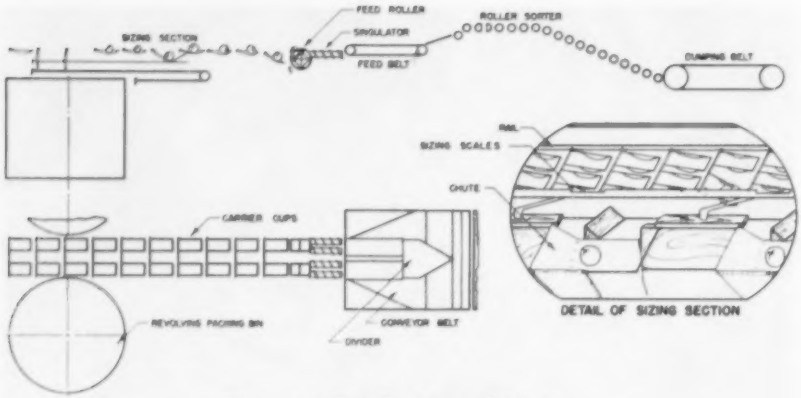

Figure 13. Details of a weight sizer

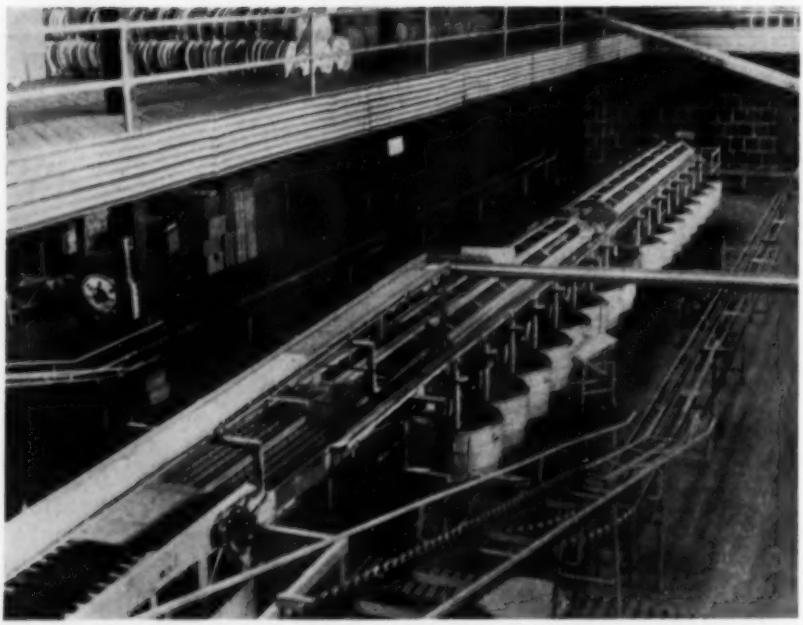

Figure 14. A large grader and sizing unit for eight sizes of each of four grades
Rotary bins with "floating" bottoms receive the fruit from the sizing unit.

limitations that make this type difficult to build. Only one make of weight grader is used in New York State. It sizes the fruit by the turning moment exerted on a spring-balance weighing system (figures 13 and 14). The turning moment is determined by the weight of an apple times the distance from its center of gravity to the hinged edge of the carrier cup. The apple is not always placed in the carrier cup in a fixed distance from the pivot. The shape of the apple may also determine the location of the center of gravity. Therefore, the turning moment is different with apples of the same weight and they are sized differently. With fairly large apples, however, the weight sizer is usually more accurate than any diameter sizer now available.

The fruit is dumped onto a rubber conveyor belt. Frequently, a chain sizer is used to eliminate all under-sized fruit. The fruit is then conveyed to a roller sorter where the leaves are removed and the fruit is graded by persons along the sides. The fruit is then transferred to another belt which is divided and conveys the fruit to the narrow belts on which they set in single file. From this narrow belt the fruit is fed onto a "singulator," which consists of two parallel rollers revolving in the opposite direction and which has a rope spirally wound around each one. From the singulator unit the fruit is fed to a feed roll which feeds each apple singly into a carrier cup. This carrier cup is timed with the feed section so that only one apple at a time is fed onto the carrier cups by the feed roll. The carrier cups consist of a webbing in a rigid-steel-spring frame. Projecting from this frame is a finger that rides along the main rail on the sizer. The spring-balanced scales are placed on sections of this rail. There is one set of spring-balanced scales for each bin. The projecting finger on the carrier cup passes over the spring scales until it comes to one which it will just over-balance. The scales are adjusted so that the largest fruit is delivered to the first bin. Succeeding scales are adjusted for progressively smaller fruit. If the fruit over-balances these scales, the projecting finger is caused to pass along the main rail and over a let-down bar descending until the fruit is deposited onto a cotton belt which transfers it to a rotary bin.

Diameter-type sizers

Diameter sizers may be roughly grouped into two groups: one that sizes by the largest transverse diameter and the other by random diameter of the fruit.

The revolving wheel type of sizers sizes the fruit by its largest transverse diameter. This is accomplished by conveying the fruit in a trough formed by two belts or a belt and a smooth surface. Brushes or rubber pads over the belt cause the fruit to spin on its cheek, with

the stem to the blossom end in a plane parallel to the plane of the conveyor belt. Theoretically, the fruit is spun so that all transverse diameters are tried while it is passing under the sizing wheel. The sizing mechanism can be adjusted for any diameter of fruit.

Two machines commonly use the principle of the revolving

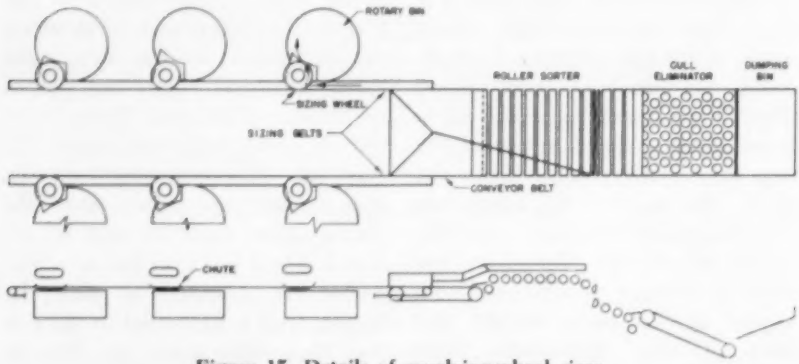

Figure 15. Details of revolving-wheel sizer

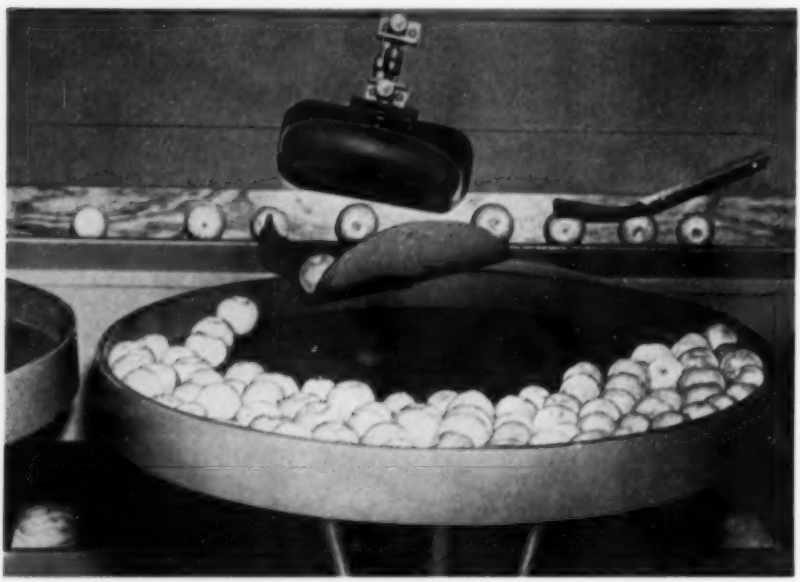

Figure 16. Revolving-wheel grader with rubber-tube ejector unit and rotary bin

wheel or drum to size the fruit (figures 15 and 16). One type usually has a gravity feed table from which the apples flow onto a cull-eliminator belt. The apples are transferred from this belt to a roller sorter where the fruit is separated into two grades. A divider board is placed lengthwise on the sorter, and the Utility grade may be placed to go down one side of the grader and higher grade apples on the other. From the roller sorter the fruit is transferred onto a fast-moving belt. On the end of this belt a V-shaped deflector forces the apples onto a sizing belt that runs lengthwise of the machine on either side. The apples are conveyed along these sizing belts. At frequent intervals over these belts are wheels similar to an inner tube and about 1 foot in diameter. These revolve at a given distance over the belts, and fruit larger than the space between the belt and the wheel are ejected off the belt into a bin. The larger apples go off first, and each successive wheel removes the next smaller size. The number of wheels needed depends on the number of sizes the grower wishes to separate his fruit into.

On the other revolving wheel sizer shown (figures 17 and 18), the fruit is dumped onto a receiving belt which conveys it to a cull eliminator. In some instances, a cull eliminator is not used and the undersize fruit is deposited at the end of the sizing belts. The fruit is then conveyed onto two narrow belts that form a V-shaped trough. The grader may be set up so the sorter is at right angles to the sizing belts or it may be parallel to the belts. The belts forming the trough convey the fruit to the sizing drums. The revolving drums are placed a given distance above the sizing belts so that any fruit larger than the space between the belt and the drum is tipped off onto a return-flow packing belt (figures 17 and 18).

The *chain type* sizes fruit by its diameter, but fruit may not be

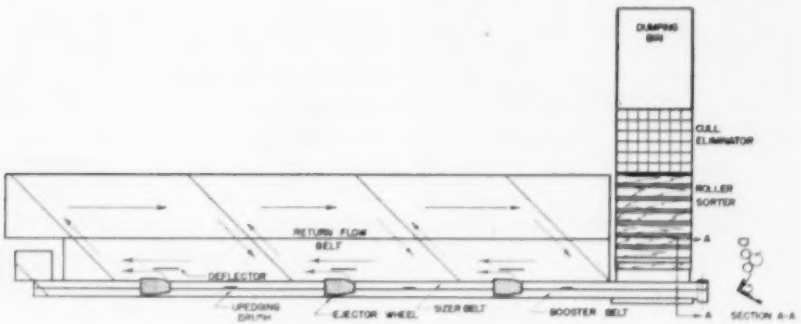

Figure 17. One type of revolving-wheel sizer

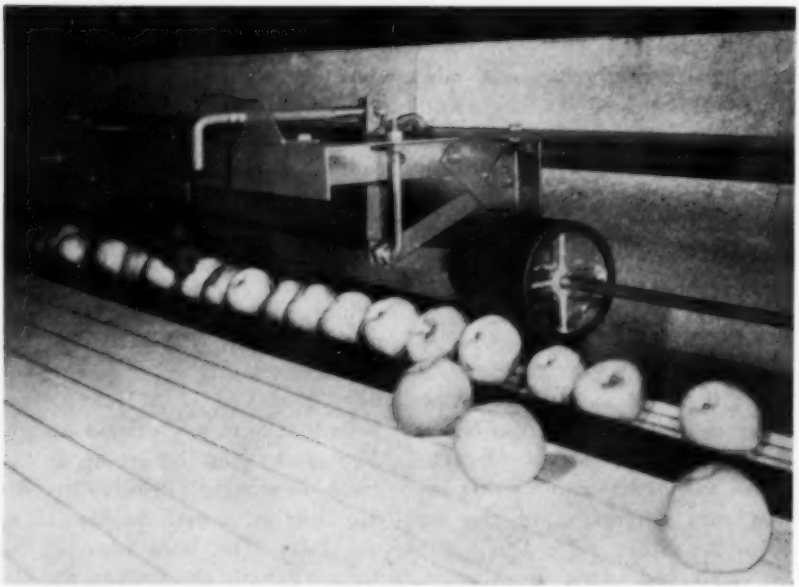

Figure 18. Revolving-wheel sizing unit with brush and ejector wheel

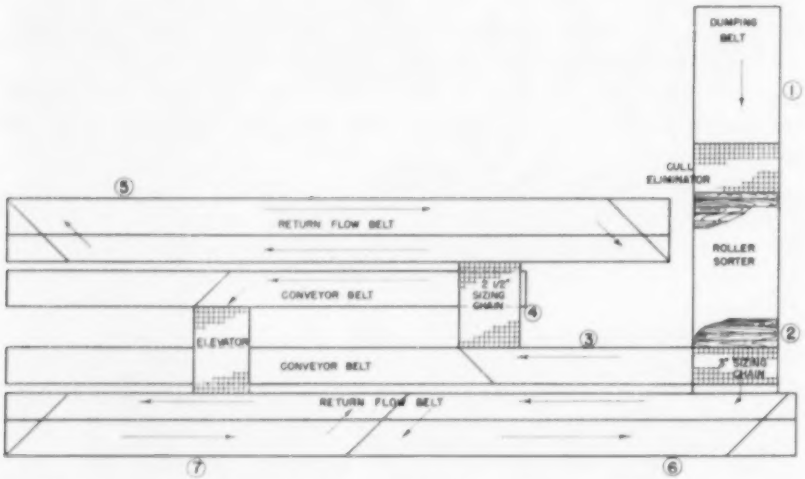

Figure 19. A chain sizing unit in which the largest apples are sorted first

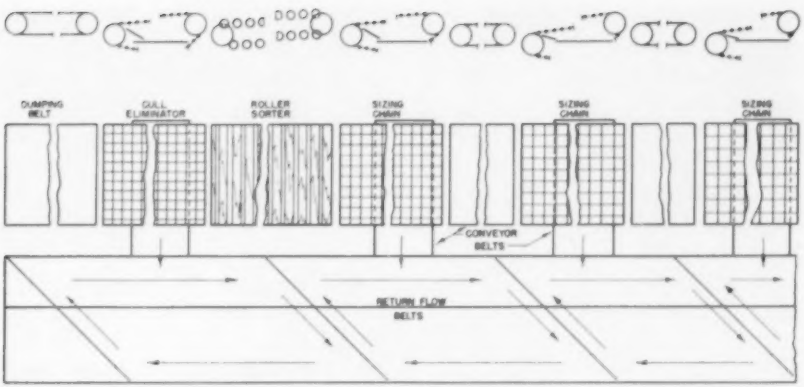

Figure 20. A chain sizing unit in which the smallest apples are sorted first

sized by its diameter perpendicular to the core. The fruit is sized in a random fashion according to the way it goes onto the sizing chain. That is, the diameter by which it is sized depends upon the position it is in when it goes onto the chain. On some machines there is a way to agitate the fruit, but the largest transverse diameter is still not always present. The chain type also lacks flexibility in easily changing the sizing mechanism to size fruit of another diameter.

There are two ways to arrange chain graders. In one, the fruit goes over the larger chains first to take out the large apples. The smaller fruit falls through the chain onto a belt where it is conveyed to the next sized chain. With this method, the apples sized are those that do *not* fall through the chain. The smaller apples, therefore, travel the greatest distance and go over the greater number of units on the grader (figure 19). The second method uses increasingly larger chains, and the apples sized

Figure 21. A bottleneck—a chain sizer too narrow

Fruit is "jammed" so tightly that some apples are forced up (arrow indicating apple) and there is severe bruising.

are those that fall *through* the chain. This type (figures 20 and 21) is probably most common in New York State. Any number of chains might be used with this type of grader, depending upon the number of sizes the grower wants to pack. The grader would, however, take up a considerable amount of space if several different sizes of fruit were to be packed.

Bins

Apples may be conveyed from the sizing units to the packers in several ways. Small graders, in general, employ gravity packing tables or bins. To insure continuous movement of the fruit to the packer, these bins must have a decided incline or the fruit must be ejected from the sizing unit at relatively high speed. The soft varieties particularly are bruised when one apple bumps into another. If the incline is lessened by adjustment, the apples tend to remain on the upper portion of the table and the packers have to pull them down with their hands or with a padded stick. A careless packer may bruise or stem-puncture apples by this method.

Modifications of the older type of gravity bin have been developed. One of these is the use of a balanced gravity circular table. The apples roll onto a round table balanced at the center so that the portion of the table with the greatest weight of apples rotates toward the packer. The chief disadvantage of such a table is that the capacity is generally no more than 1 bushel one layer deep (figure 16). Consequently, the bins overfill rather easily and the apples may fall to the floor as the bin rotates or they may pass the desired sizing unit.

The so-called floating gravity bin is another adaptation of the standard gravity table (figure 14). The floor of these bins is supported on springs. As the apples fill the bin, the supporting springs contract and allow additional layers of apples to roll into the bin. This type of bin lessens the possibility of "jamming" because of its large capacity. If, however, the apples become more than one layer deep, there is an opportunity for bruises and stem punctures.

Return-flow endless rubber belts are also used to move apples from sizing units to the packers. The advantage of these relatively wide belts is that they move a large volume of fruit at a slow speed and there is less bruising from contact of apples with each other or with the sides of a bin. The roll or drop from the sizing units is minimized as the fruit is *conveyed* away. The return-flow belts tend to prevent "jamming" because apples that are not removed by the packer the first time they pass him are shunted onto a return belt and are eventually shunted back onto the packing belt. The shunts can be easily removed by combining two or more sizes if necessary, and allowing more packing space for a given

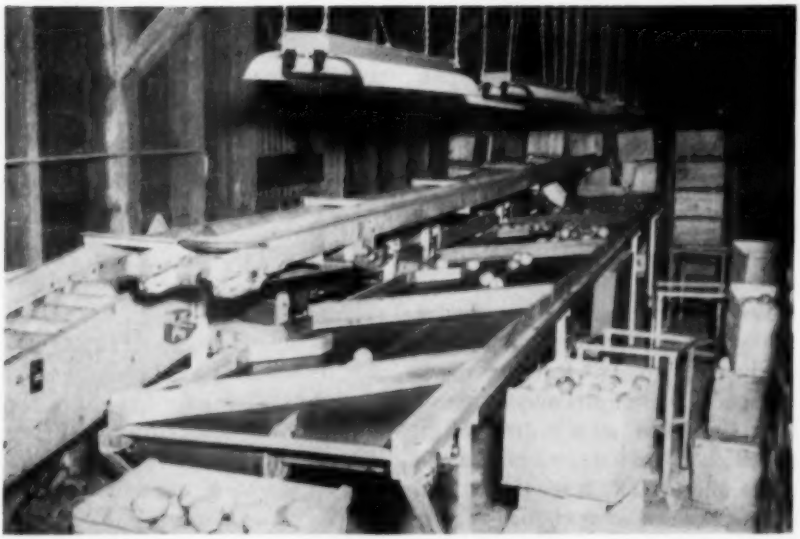

Figure 22. A return-flow packing belt on a chain grader
Note excellent lighting for packers.

size if the fruit is predominately one size. Tests have indicated less bruising on return-flow belts than on any type of packing bin or table (figure 22).

Selection of a Grader

TO SELECT the best grader for a given operation, the grower or packer must know exactly what his conditions are and what he wants the grader to accomplish. Several manufacturers build custom-made graders to fulfill specific requirements.

The variety or varieties of apples to be graded and the condition of

Figure 23. Fruit rolling down an incline and striking the sharp, unpadded corner of the grader

The fruit is badly bruised in this operation. Graders should be well padded where fruit is apt to strike it.

the fruit when graded are important considerations. Some graders tend to bruise soft-fleshed apples more than others. To judge the potential possibility of bruising and stem punctures during grading, sizing, and packing, one should observe the grader in action. The following considerations should be kept in mind.

Fruit bruises on a grader when it contacts a hard surface or another apple with enough force to crush the cells. The fruit may strike a hard surface when it is dropped or rolled onto various parts of the machine (figure 23). It may strike another apple when it changes elevation, such as in dumping, and when dropped from one unit to another, or when it is transferred to a unit moving at a much different rate of speed (figure 24). In most instances, the surfaces on a grader can and should be padded with cushioning material to prevent bruising. The problem is to prevent one apple from striking another. It is, therefore, important if much soft-fleshed fruit is to be graded that the grader have as few places as possible where the fruit must change levels in going from one unit to another. Also, that there be no sudden changes in speed of the units. It is difficult to prevent fruit from bumping against other fruit when it is transferred on a unit that is moving at a rather high rate of speed. A slow, constant rate of travel of the fruit on a grader is best.

Figure 24. Soft-fleshed apples bruised in rolling from sorter onto sizing chain
The difference in height between the two units should be kept to a minimum.

Figure 25. Apples badly bruised from falling several inches into packing containers

Fruit should be carefully placed in containers and not dropped as is done here.

Various tests indicate that sponge-rubber-covered roller sorters greatly reduce bruising in the sorting operation. Also, a return-flow belt is much more satisfactory to pack from than are gravity bins. With a return-flow belt it is not necessary to have a drop between the sizing unit and the belts and it is much easier for the packers to select the fruit for the pack. Such equipment is especially recommended for the grower who packs a large amount of McIntosh apples.

Fruit bruises considerably as it goes over the cull eliminator. On graders that size the large fruit first, with each succeeding sizer taking out smaller fruit, there is no need for a cull eliminator. The undersize fruit can go to the end of the sizer into a box or bin. This can be done easily on the revolving wheel type of sizers. The larger fruit is subjected to less travel on the grader.

The number of sizes to be packed and whether the operator wishes to combine sizes are important considerations. Apples are frequently packed in ¼-inch sizes or larger. With apples being packed in a uniform "cell pack," there is more need to separate fruit into ⅛-inch size groups. The accuracy of the grader in separating the fruit into small size variations is more important.

In general, the weight type of grader is more accurate than the diameter type of sizers for apples 2⅛ inches and larger. Graders with revolving-wheel ejectors are better than chain-type sizers. Both are well adapted to packing in ¼-inch sizes; however, there may be some difficulty with the ejector-wheel type on varieties that are not quite round or are irregularly shaped. Either type is well adapted to pack in two grades of equal volume. The chain types of graders are well adapted to packing a large volume of fruit in a relatively small number of sizes. Graders with return-flow belts are well suited to combining sizes by moving shunts onto the belts. A disadvantage of many of the graders is that smaller, less

expensive equipment suitable for a grower with a small volume separates the fruit into but few sizes.

The number of bushels an operator plans to pack in a day generally determines the size of the grader needed. The length of time during which the fruit must be packed is also important. If one plans to pack all the fruit in the fall and has a high proportion of McIntosh, he may need a larger grader than his neighbor who has more of a later variety and can pack his fruit over a longer period. In a survey conducted several years ago, growers indicated that they packed an average crop in less than thirty days. If one has a farm storage or packs from a commercial storage, a smaller grader is satisfactory. The survey also indicated that it is wise to assume that any grader will pack no more than 80 per cent of its rated capacity under actual operating conditions. Under ordinary conditions, it may not average more than two-thirds of its rated capacity. It is a good idea to check the capacity under average conditions with various operators of graders.

Containers

Boxes

The standard apple sales package in New York for many years has been the Northeastern box. The inside dimensions are 17 by 13 by 11 inches and it holds 1⅛ bushels. This box is packed level full without a bulge. It holds as many apples as a Northwestern box with a bulge. The bulge was eliminated to reduce bruise damage to the fruit. The Northeastern box is usually covered with a fiberboard pad and two or three 1-inch slats. Some growers use a unitized cover made from wood veneer.

Some buyers prefer boxes packed one way and some another. One common method is to "face and fill." The packer turns the box upside down with the lid in place but with the bottom removed. He "faces" the apples across the top of the box, packing them in regular rows across the box so that the red sides of the apples will be facing the buyer when the lid is removed. He fills the rest of the box without any attempt at regular placement and then nails on the bottom.

Another method is to "jumble pack." The packer merely puts the apples into the box without any attempt at regular placement. Still another way is to "layer pack." A fiberboard pad between each layer of apples acts as a cushion and prevents considerable bruising. The apples are placed in regular rows. Sometimes they are merely placed on the pad with the calyx end down, to fill the layer so that the apples do not shift around with movement of the box.

A few growers wrap each individual apple in the Northwestern fashion and then place each apple on its side in regular rows. Place-

ment diagrams may be obtained by writing the Department of Pomology at Cornell University, Ithaca, New York. "Wrap packing" apples to fill without over-filling the container takes considerable care.

Cartons

Many growers pack apples in fiberboard cartons. These cartons, however, do not have the mechanical strength of boxes nor can they withstand long-time storage under humid conditions. They lend themselves easily to advertising lithographing and are often more easily available and cheaper than wooden boxes.

Cartons may be packed "face and fill," "jumble," "layer," or "cell." Cell cartons provide the utmost in fruit protection, for each apple rests in its own compartment after the fashion of an egg carton. Layer pack and cell cartons are marked as to count and not as to cubical content of the boxes. Some growers use the "Friday pack" or "KysPak" pack, where each apple is nested in its own cushioned compartment.

Baskets

The bushel basket is seldom used because the softer varieties may be badly bruised. Solid or built-up bottom baskets give more rigidity than other types. Furthermore, baskets waste considerable space in shipment and in storage.

Consumer Packages

Any container is potentially a *consumer package*, but this term usually refers to a package that holds less than 1 bushel. A variety of consumer packages are available, such as plastic bags in varying sizes; small fiberboard cartons, which may or may not be overwrapped with plastic films; paper bags with a plastic film "window"; or mesh-type bags. All consumer packages require a master carton for shipment.

The subject of consumer packages and prepackaging in consumer size units is too vast a field to cover in this bulletin. The following should be considered, however, in evaluating a given consumer package:

1. Does it hold the number of apples most appealing to the consumers?
2. Does it have "sales" appeal because of its appearance? For example, red apples usually sell faster in purple mesh bags than in red ones.
3. What are the characteristics of the plastic film used? If the film is impervious to the movement of oxygen and carbon dioxide, the plastic bag must either have an open neck or it must be perforated. Does the film tear easily? Does it fog readily with condensed water? What is the appearance of the film? For example, a cloudy film is often preferable to a clearly transparent film for bags.

Consumer packages should not be looked upon as storage contain-

ers, because scald develops badly on certain varieties enclosed in plastic type containers and only "fresh pack" apples should be sold. The consumer package must contain only high-quality fruit. No scald, decay, or bad bruise damage must be evident on the fruit. The consumer package must, therefore, be packed just shortly before sale.

Mechanized Handling

MECHANIZED handling refers to eliminating as much hand labor as possible by the use of mechanized equipment. A full discussion of this topic is impossible in this bulletin. Published reports of the United States Department of Agriculture may be obtained for a complete study of apple-handling methods.

Advantages

Much less labor is required in mechanical handling than in hand handling. It is not uncommon for one man to do the work of three or four and in less time when mechanized equipment is used.

Fruit is handled faster, too. It is brought into the packing house or directly into the storage faster than is possible with hand labor. This should mean better fruit condition after storage.

There is less congestion in the packing house. Because of faster handling, there should be less stock-piling of fruit in the packing house.

It is easier work than hand labor. Lifting boxes and especially piling boxes by hand high in the storage is disagreeable work.

There is less bruising. In unloading trailers and piling boxes in the storage by hand, the workers may drop the boxes into place, thus bruising the fruit.

There is more efficient use of tractors, trailers, or trucks that haul the fruit from the orchard.

Disadvantages

The capital outlay for mechanized equipment is considerable. A fork-lift truck usually costs from $2000 to $4500. Each pallet, depending upon the type, costs from $1.50 to $3.50. Because of reduced labor costs, mechanized handling should be cheaper than a hand operation. Of course, with a 10,000-box operation, the costs may exceed those involved in manual handling. It is not known what the minimum size operation should be to justify the expense of mechanization. With high labor costs, it would seem reasonable to estimate that mechanization is justified for growers who handle 25,000 boxes or more.

Some plants are not adapted to mechanization. A well-operated fork-lift operation involves an unloading apron, with the packing house and storage at ground level. One has to consider floor strengths, size of doors, presence of posts, ramps, and other impediments to efficient operation.

Palletizing involves some waste space. The pallets themselves take up some space; for example, a single-face pallet takes up about 3 inches and a double-face pallet takes 6 inches in height. Furthermore, a lift truck needs wide aisles and requires from 6 to 10 or more feet to turn at right angles. Often it is desirable to be able to take blocks of fruit out of storage at right angles to the aisle. The maintenance of this wide aisle means a considerable loss of space. Of course, the aisle can be partially filled with one pallet or more wide by backing the fork lift out of the storage. The aisle would then have to be cleared before different blocks of fruit could be taken from storage at will. In smaller rooms, the relative amount of space lost by palletizing is greater than in large rooms. For example, in a 25,000-box room with double-faced pallets, a 19-foot ceiling, and a 7-foot aisle, there is almost a 20 per cent loss of space as compared with hand piling. In a room holding 50,000 boxes, the loss in space would be somewhat less but it still would be considerable. With clamp-type lift trucks there is less wasted space because there are no pallets. With single-face pallets, less space is lost than with double-faced pallets.

Types of Mechanization

Mechanization is a matter of degree. Few packing houses today operate on a complete hand operation.

Conveyors

There may be a complete or incomplete conveyor system. For example, gravity conveyors may move the apples from the trailer to the stockpiling position in the packing house. Conveyors might be used to move the packed boxes away from the grader bins (figure 26). With a more complete system, powered conveyors would move the apples to the end of the grader. Following the lidding operation, powered conveyors would move the boxes into the storage. Conveyor systems are relatively simple and require little upkeep. They involve only small doors or ports into a storage room. Boxes on the conveyor can move a flap at the port into the storage and thus minimize the infiltration of warm air into the storage space. Whether or not a conveyor system is cheaper than lift trucks depends in part on how much powered equipment is used. A conveyor system is somewhat less maneuverable than lift-truck equipment. Conveyor equipment, even though it involves an escalator to move boxes to the stacking position, still involves hand piling and unpiling.

Skids

Boxes of apples may be moved around the packing house and into the storage on skids. The skids are

Figure 26. Easily reached empty packing containers

A conveyor such as this is an excellent arrangement. Note the box tilting device for easier packing.

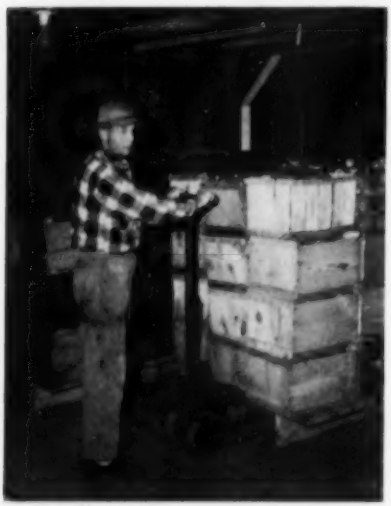

Figure 27. A hand truck to move pallets on skids around packing shed or storage

like single-faced pallets except they would not be stacked one on top of the other with loads of fruit on them. They have 6- or 8-inch stringers or "runners." The skids can be moved either by a hand-operated low lift or by electric-powered low lifts (figure 27).

Tow trucks

Electric- or gas-powered tow trucks can pull "trains" of carts or wagons loaded with boxes around the packing house or into storage. Of course, with these there is also hand piling and unpiling in storage.

Elevating equipment

Many powered "elevators" are available. One type elevates a skid load of apples to the stacking position where the boxes are hand piled or unpiled. Another type, an adjustable, inclined conveyor or "escalator," raises the boxes to the piling position. A relatively inexpensive "high piler" is also available. For stacking twelve high, the first six boxes are put into position with a hand-operated clamp truck. The high piler puts the next six boxes on top of the lower six and will also unstack the top six boxes. There is a 2-inch space between rows of boxes for the operation of both the clamp truck and the high piler.

Clamp-type lift truck

The clamp-type lift truck has two hydraulically operated clamps that hold onto the load of twenty-four or more boxes by putting pressure on the lower tier of boxes. The pressure is well enough distributed so that it should not break the boxes unless the boxes are in poor condition. The main advantage of the clamp truck is that it requires no pallets, which is a savings in cost and in space in storage. Some space must be left between the unit loads, however, so that the clamps can be introduced and withdrawn. More care is required in stacking unit loads on top of each other than with pallets. For example, it would be difficult to line up the third load on top of the second unit. The top loads can rest on strips nailed on the ends of the top boxes of the first two unit loads.

Fork-type trucks

A powered lift truck with two forks introduced into a pallet to lift the pallet into position can pile the units higher and somewhat easier than can clamp trucks and there is less danger of breakage of boxes. A wide variety of fork lifts are available. Some, for example, are counterbalanced. As the pallet load is lifted, the collapsible mast is tipped backward before the truck begins to move. The machine is counterbalanced by positioning much of the weight of the machine at the opposite end of the pallet load. In contrast, is the straddle type of fork lift. With this type, the weight of the pallet load rests on two "legs" with wheels that extend under the pallet. This means that a straddle type of fork lift requires the use of wing-type pallets. The straddler type requires less turning radius than the counterbalanced type.

Some fork lifts are powered by gasoline engines and others by batteries. The batteries of electric fork lifts are charged during the night, although some operators have extra batteries for operating longer than a 10-hour day. The gas-operated truck is cheaper in first cost than an electric truck. Gas trucks are usually depreciated over a ten-year period and electric trucks over a

twenty-year period. Hence, the actual operating cost may be no more or may even be less with an electric truck. The electric truck should involve less repairs than a gas truck. Gas trucks give somewhat smoother operation in starting and stopping than do electric trucks. Gas trucks can, however, be operated on pneumatic tires whereas electric trucks cannot. Pneumatic tires mean that floors need not be so smooth and they tend to wear out the floors less than do hard wheels. Gas trucks are commonly seen in unloading yards at the packing house.

A real question exists as to whether gas or electric power should be used in closed spaces, such as in the storage room. Carbon monoxide from the exhaust fumes is a deadly poison to humans. A number of persons have been made violently ill by working in rooms with gas-operated motors. The amount of carbon monoxide present in the room depends on the amount of ventilation in the room, the combustion mixture, the horse power of the motor, and other factors. At present, a number of storages use gas-operated trucks with a special "catalyst" muffler that is supposed to break down the carbon monoxide. The mufflier is not effective unless the motor is at normal heat and white gas is used. That means that one should not enter a storage room with a cold motor. Whether these mufflers are completely effective is still a moot question. Many storage operators prefer electrically operated lift trucks to prevent any possibility of danger to humans and any possible danger of gas fumes to the fruit.

Some fork-lift trucks are "ride" type and others are "walk" type. The ride type is, of course, more convenient for the driver. Some walk types are actually ridden by skilled operators. The ride types are usually somewhat more expensive and require a wider turning radius than that needed by the walk type.

A 2000-pound-capacity fork lift is large enough to handle single pallets of apples. When the top two pallets must be stacked at one time, a 3000- or 4000-pound-capacity truck is necessary.

Pallets

Pallets should be constructed of moisture-controlled hardwoods. To prevent splitting the wood, holes are drilled for the hardened-steel, cement-coated nails. Package size and arrangement and number of packages on the pallet determine pallet size.

Double-face pallets have both a top and a bottom surface made of four and six boards 1 inch thick. Stringers or uprights (2 by 4's) separate the two faces. Double-face pallets allow for good distribution of the weight load, as one pallet rests on a pallet load below it. Hence, stacking is somewhat easier than with single-face pallets where the weight rests only on the

stringers or uprights. Single-face pallets, however, are cheaper and take up less space than double-faced pallets. On double-faced pallets, the top edges of the lower face of the pallet are chamfered to allow for easy entry of the low-lift transporter.

Two-way pallets can be entered with the forks only from front or back. Four-way pallets can be entered with the forks from all four sides of the pallet. Two-way pallets are satisfactory to handle apples.

Some precautions in planning for palletizing

Fork lifts with their pallet loads are heavy. Hence, floor strength must be carefully considered, especially when small, steel wheels are used on the fork lift. Relatively "dry" concrete must be used and then slowly cured. The strongest wearing surface can be made only by using a relatively dry concrete mix that is vibrated into place with a special machine.

For efficient operation, at least 6 inches should be added to the manufacturer's specifications for minimum turning radius for a lift truck. An allowance for at least a 1-inch space between pallets must be made.

A 4-inch curbing at the walls of the storage not only keeps the truck operator from bumping the walls but also allows for good air distribution back of the stack.

One should lay out a pallet plan for both the packing house and the storage room so as not to waste space and yet to allow for efficient piling of pallets and for good air distribution in the storage.

New pallets should be inspected as to dimensions before acceptance. Small variations in width and length do not matter so much as variations in height. All boxes should be the same height. Field crates have been found to vary as much as 1 inch in height. Height variations can cause pallet loads to tilt and lean.

A Plan for Mechanized Handling

No one plan fits the needs of all packing houses and storages because scarcely any two plants have the same procedures. One actual plan is given in the following paragraphs to show some of the items that had to be considered.

In the orchard

Fork lifts that attach to a tractor are available. These attachments

Figure 28. A fork-lift attachment on the front of a tractor

Pallets are loaded in the orchard onto trailers or trucks.

mount on either the front or rear (or both) of a tractor (figure 28). Generally these are used where one has no storage on the farm and wishes to handle pallets from the orchard to packing house or loading trucks. With this system, pallets are placed in the orchard, and the field crates are placed on the pallet. The tractor fork lifts then loads the pallets onto trailers if the fruit is going to a farm packing house or directly onto a truck if it is going to the processors. The pallets may be carried out of the orchard on the tractor lift and loaded onto a truck at the edge of the orchard.

Some farmers have used tractor "loaders" for pallet handling. A set of forks are made to attach to the loader. Some system such as a parallel-bar linkage is used to keep the pallet level. This rig is then used to load pallets as any other type of lift is used.

Such an operation seems of doubtful value in this particular operation. Distances to the packing house do not seem to justify hauling 30 or 60 box loads. Hence, two tractors and two trailers are used in the orchard. Each trailer carries six empty pallets to the orchard where they are loaded by two loaders and the tractor driver. They "level" off the crates. Each pallet is 36 by 45 inches since only field boxes are used. The pallets are the wing-type because a straddler-type fork lift is employed at the packing house and storage.

The pallets are loaded in a 2-by-3 pattern three boxes high, giving

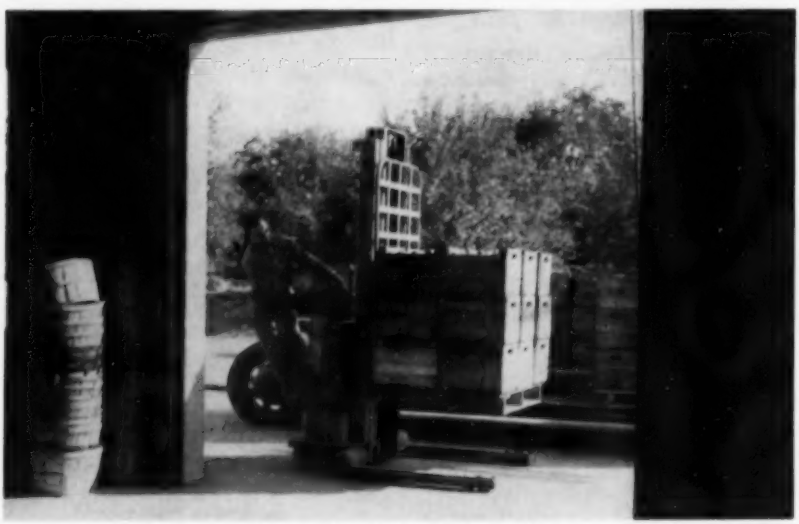

Figure 29. Fork-lift unloading pallet loads of apples from trailer onto unloading apron at front of packing house

a total of 18 boxes per pallet. If the pallets are five high (30 boxes), the load must be roped on to prevent the boxes from tipping off during transportation to the packing house. If the pallets are to be piled five high at the packing house, the trailer can be only partially palletized. The unpalletized boxes are used at the packing house to build the pallet up to five high.

In the packing house

The trailer load of boxes on pallets arrives at the packing house on a concrete unloading apron at floor level with both the packing house and the storage. A straddler-type fork lift unloads the pallets of apples on the apron beside the trailer (figure 29). *Alternate 1 :* If temporary waste space is not a problem, the pallets are merely set on the apron and the trailer goes back to the orchard in less than five minutes unloading time. The fork lift takes the pallets (three boxes high) into the packing house or into the storage where they are high piled while waiting for the next trailer. *Alternate 2 :* If the apples are to be stored for some time before grading, it is important to use all the available space in the cooler. The fork lift then lays the pallets on the apron and the tractor driver builds the pallet loads up to five high (thirty boxes per pallet) while the fork lift takes full pallets into the storage.

When apples are graded during the picking season, the packing house is kept supplied with a half day's backlog of eighteen boxload pallets. Pallets can be stacked two high in the packing house. The man operating the automatic dumper on the grading machine brings pallet loads of apples to the dumping position with a low-lift, hand-operated transporter. He sends empty boxes to the packers on an overhead gravity conveyor that runs the length of the grader. The fork lift conveys full pallet loads of packed boxes to the storage.

In the storage

The storage-room door is opened and closed by pulling a rope that activates an automatic door opener. Before this pneumatically operated opener was installed, the storage-room door was left open for several minutes and considerable warm air entered the cooler.

Full pallets are stacked three high by the fork lift, (figure 30). Eighteen-box-load pallets are piled four high, with the top two being piled together in a one-lift operation. The pallets are stacked at right angles to the 6-foot 9-inch aisle. The aisle can be partially filled temporarily with pallets by the fork truck backing out of the aisle.

Special equipment required

In this mechanized plan outlined for a 25,000-box storage, the following special equipment was employed. The grower bought 830

Figure 30. A fork-lift stacking apples three pallets high

Note wing-type pallet on fork lift.

double-faced, wing-type pallets at a cost of $1600 in 1953. A straddler-type, electric fork lift with 150-inch elevation and collapsed height of 96 inches complete with batteries and charger, cost $3300 in 1953. A hand-operated low-lift transporter costing $486 was used to supplement the operation of the fork lift. A concrete apron 30 feet long and 26 feet wide was installed for unloading at the packing house. Refrigerator doors were 5 feet wide and 8 feet 6 inches high to accommodate the fork lift with pallet load. A pneumatically operated door opener was installed on the refrigerator door.

The Packing House

The size, shape, and arrangement of packing houses are extremely variable. Much of the fruit grown in New York is packed on the farm in buildings designed for some other use. Those who have farm storages usually have a packing shed attached to it. Some of these buildings are not arranged for the most efficient operation. To determine the size and shape of a packing room, an operator has to consider how much space he needs for the grader and how much space he needs around the grader to handle the fruit, as well as the space needed for the unpacked fruit, the packed fruit, and the empty containers.

The efficiency with which a farm storage and packing house can be operated depends to a considerable extent on how well it is planned. The layout of the packing house should be such that the fruit can be moved through the various steps involved in grading, packing, storage, and in merchandising with a minimum of effort and expense. A packing room adjacent to the storage is most desirable. The method and the equipment used to move the fruit to and from the grader are important. The equipment should be arranged also so that fruit can be handled directly into storage or

out of storage and directly into trucks or through grading line with a minimum of confusion and labor.

Size and Layout

A survey of packing houses in the main apple-producing areas of New York was made by Melvin Hurd to determine the number of bushels packed per hour, the floor space, and the room dimensions. It was found that on the average the floor space needed for the most efficient packing operation was approximately 24 square feet per bushel per hour.

Small packing rooms may be nearly square in shape. Usually the larger the packing room, the greater its length should be in relation to its width. This varies somewhat, depending upon the type of grading equipment that one has and the method of handling the fruit to and from the grader. One should keep in mind that in general the large-capacity graders are longer than small ones with relatively little change in width. Also, it is more efficient to store unpacked fruit at the dumping end and packed fruit at the end where the fruit is packed and ready for storage or shipment. If one is considering the use of pallet handling of the fruit at some time, the room should be wide enough so that the lift truck can pick up the pallets beside the grader, turn, and carry them to the storage (figure 31). Posts are undesirable in a room, particularly if lift trucks are to be used. To eliminate posts in a fairly wide room, it may be necessary to use a trussed rafter.

It is also important to locate the packing house and the storage on ground level if fork-lift trucks are to be used. At least two sides of the packing area should be readily accessible by truck or trailer. In some places it may be desirable to have a loading dock at truck-bed height, particularly if the grower uses conveyors instead of a fork-lift truck.

Ceiling Heights

The packing room should be at least 8 and preferably 9 feet high if overhead conveyors deliver the empty packages to the packers. One should allow 6½ feet of head room for the workers, and overhead

Table 2. Floor Dimensions for Packing Rooms

Volume to be packed	Minimum	Dimensions maximum	Optimum
Bushels per hour	*Feet*	*Feet*	*Feet*
50	26 by 30	34 by 50	34 by 40
100	32 by 40	40 by 90	36 by 70
150	36 by 60	40 by 100	40 by 80
200	40 by 80	40 by 100	40 by 100

conveyors may require 30 inches additional space. Most growers seem to prefer overhead doors, and it should be remembered that additional space must be provided if they are to be used. If trucks drive into the building, at least 12½ feet of height is needed to accommodate large trucks. While ceiling heights must be adequate, increasing the height adds to the expense. Furthermore, unnecessary clearance is undesirable. High ceilings also increase the cost of heating, and frequently it is necessary to provide heat in the packing room during late fall or winter.

Storage Space for Empty Containers

There must be some storage space for empty containers. This may be either on the packing-house floor or above the packing-house floor, where the packages are moved by chutes to the packers. Empties that are stored overhead are always readily accessible and one man can feed them down as rapidly as needed. The advantage is that the packing-house floor need never be used for the storage of unfilled containers. With smaller operations, however, this is undesirable because the man who performs this service must be on duty at all times and he cannot help with any other packing activities. When the volume of fruit is not too large, he is not kept continuously busy and, therefore, the system is rather inefficient. Particularly for the smaller operations, storage of empties on the packing-house floor seems the best arrangement. Also, it should be kept in mind that very high piles of stock from which boxes are made become heavy and the supporting members must be heavy enough to carry this load. This may mean considerable extra construction.

Good Lighting

Good lighting is important for most packing operations. Natural lighting is best. Frequently, however, it is difficult to provide adequate daylight where it is needed and packing operations are often carried on during dull days or during late afternoons and evening. It is, therefore, necessary to provide adequate artificial light. Because of the shape of fluorescent tubes and the quality of light which they emit, many operators like them for packing-house installations. The tubes or bulbs should be placed and shielded in such a way that the light will fall onto the work and not shine directly into the eyes of the employees. The single-tube fluorescent light is not satisfactory because of its so-called "stroboscopic" effect. Fixtures containing two or more tubes should be used. This eliminates the unpleasant flickering.

In many packing houses, lighting conditions can be greatly improved by applying a coat of light-colored paint to the ceilings and interior walls.

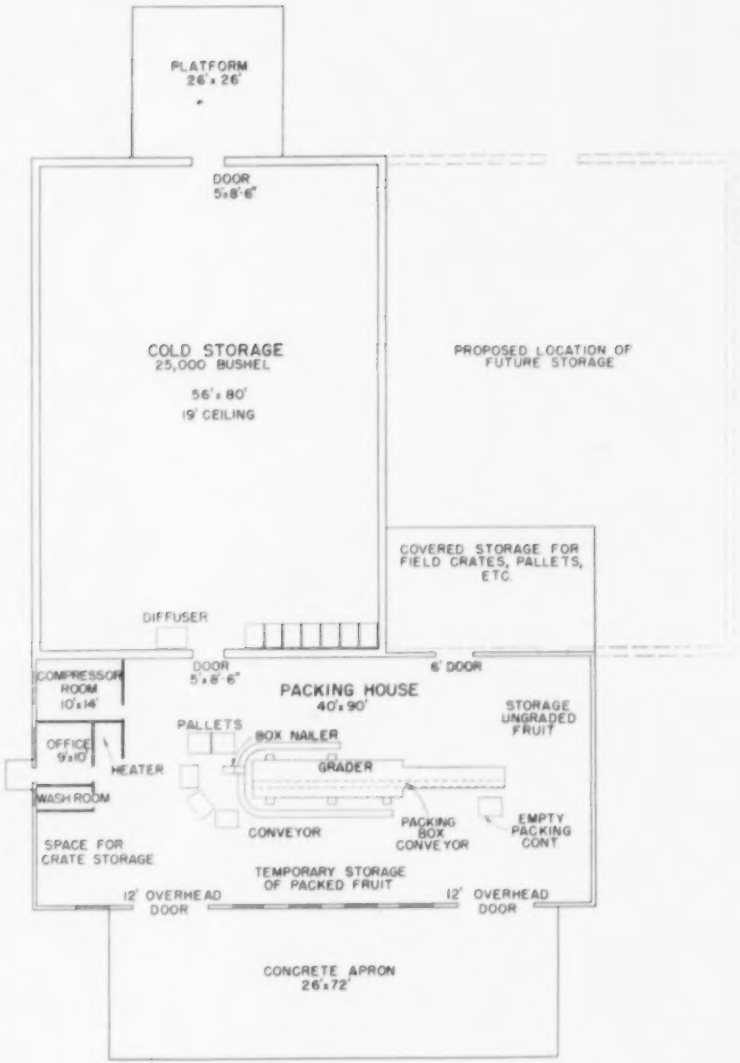

Figure 31. Suggested plan for apple-packing house

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